Proposal
1-310
for

CHEMICAL PROCESSES IN THE AGING OF PHONOGRAPH RECORDS AND TAPES

to

Library of Congress
Washington 25, D. C.

Attn: Dr. Harold Spivacke
Chief, Music Division

Prepared by:

Herbert C. McKee, Manager
Industrial Pollution and
Analytical Research

Southwest Research Institute
8500 Culebra Road
San Antonio 6, Texas

W. E. Thompson, Chairman
Department of Chemical
Research

March 10, 1959

I. INTRODUCTION

During the course of Southwest Research Institute Project 721-2 for the Library of Congress, a small amount of work has been done in studying the chemical changes in the composition of phonograph records as a function of aging time. Numerous significant differences have been measured. It appears that these differences can be used to provide a quantitative measure of aging, predict the useful storage life of phonograph records, suggest methods by which the storage life of the record may be increased, and possibly lead to new and improved record formulations.

This proposal outlines a research program to obtain the necessary information concerning the chemical changes involved in the degradation or aging of records. The project as proposed here would have the following objectives:

(1) To provide basic information on the chemical changes accompanying degradation or aging.

(2) To provide information leading to the development of chemical test methods to measure degradation and give a positive indication of the need for re-recording before any loss in fidelity has occurred.

(3) To use the information developed to suggest feasible methods for preventing or decreasing the rate of degradation.

II. SUMMARY OF PREVIOUS RESULTS*

A. Nitrocellulose or "Acetate" Discs

The film of the nitrocellulose disc consists of nitrocellulose, plasticizer, alkyd resin, and a small amount of dyestuff and pigment (the pigment is added as a stabilizer and carrier for the dye). Based on the chemistry of the constituent materials, the following changes were predicted; these predicted changes are compared with the chemical analytical results obtained:

(1) It is expected that the nitrocellulose will decompose continuously with time to give oxides of nitrogen. These nitrogenous gases may be expected to cause degeneration of the record in several ways.

a. They may lead to the formation of nitrous acid, which will act as a catalyst for the degradation of all the constituents, or they may bring about further polymerization or crosslinking of the nitrocellulose and the plasticizer causing embrittlement. Further, they may oxidize the plasticizer or cause the cleavage of the cellulose molecule to produce several organic acids. In the experimental

*For a more complete discussion, see Technical Reports issued on Project 721-2, Southwest Research Institute.

work it is clearly shown that the acidity of an aged nitrocellulose disc is greater than that of the unaged disc, as may be expected from the production of nitrous acid and the various organic acids predicted above.

The broad infrared absorption at 6 microns is due primarily to organic nitrates and indicates that the nitrocellulose content of the aged material has been reduced. Absorption by the new material at 7.79 microns is due to organic nitrate and substantiates the loss of nitro groups from the nitrocellulose as it decomposes. The reduction of absorption at 7.83 microns with aging is still further evidence of the loss of nitro groups from the material with age.

The strong absorption at 2.8 to 3.2 microns in the aged material is due to an increase in organic acid content of acids similar to acetic.

The greater yellowing of the extract of the aged disc over that of the unaged disc is

consistent with the formation of oxidation products as postulated above.

b. It is expected that the polymeric chain of the plasticizer will be cleaved by the action of the nitrogen oxides and that lower molecular weight organic acids will be formed. The infrared spectra obtained from the extract of the record material contains a number of peaks which show a real difference between the new and aged records. The decrease in absorption at 3.43 microns shows a loss of methyl groups, indicating depolymerization. Decrease in the absorption at 3.53 microns indicates the cleavage of the plasticizer at double bond sites, resulting in the formation of smaller hydrocarbons or acids which, of course, will have a higher vapor pressure and will be lost more readily by evaporation.

c. It is expected that the plasticizer will polymerize further and crosslink by isomerization. In spectra obtained on samples of the material which had been dissolved in acetone but not filtered or otherwise treated, increased

absorption at 1.75 microns indicates the presence of more cyclic or crosslinked molecules, strongly indicating that further polymerization of the plasticizer had taken place with age.

The chloroform extracted material shows no plasticizer from the old films. The obvious interpretations are that the plasticizer has either polymerized to such an extent as to be no longer soluble or has broken down to small units and evaporated. Probably both processes are occurring.

d. It is expected that the dye will be affected by oxidation or hydrolysis with time. Aged films which were chloroform extracted gave evidence of soluble dyes, while the new film did not. This clearly shows that the dye has been altered, probably by oxidation.

e. The alkyd resins should be relatively stable, and no evidence of change was found.

B. "Vinyl" Records

The major constituent of the "vinyl" record, the vinyl chloride-acetate copolymer, would be expected to decompose in the following manner:

(1) The first decomposition stage should be a dehydrohalogenation resulting in the formation of hydrochloric acid (HCl). It would be expected that acetate groups will also be removed and result in the formation of acetic acid. A simple pH measurement does not indicate in this case a lower pH (greater acidity) for the old record than for the new one. The tribasic lead sulfate, which serves as a stabilizer in the vinyl plastic records, is apparently functioning in an efficient manner by neutralizing the free acids and thus preventing them from acting catalytically upon the other components. This subject needs further examination.

report p 46? higher

(2) Even though the pH measurement does not indicate the formation of acids, we suspect that such a process must be going on and this would lead to increased olefin content in the aged record. In the infrared spectra of the two materials the absorption

band at 3.33 microns and the broad band of absorption at 7 microns indicates that the old sample contains more olefins than the new material.

(3) We should expect that air oxidation will bring about the formation of epoxy type polymers, which are easily crosslinked to form brittle products. The increase in absorption in the infrared spectra at 3.45, 3.55, 7.30, and 7.55 microns with age denotes an increase in polymerization products and crosslinking of the aged vinyl copolymer and the formation of oxidation products.

(4) Other peaks in the infrared spectra show the formation of esters, carbonyl groups, and organic chlorides. A control method might be based on the forming of carbonyl groups.

III. EXPERIMENTAL PROGRAM

A. Introduction

The previous small amount of work provided unmistakable evidence of qualitative changes in chemical composition of records as a result of aging, in line with the chemical changes to be expected of the materials constituting the record. The proposed new work would be aimed at providing quantitative data

on the chemical changes. Further, the aging required to initiate measurable reactions must be determined and the relationship between the amount of chemical degradation and the beginning of deterioration in sound quality would have to be determined.

B. Accelerated Aging Tests

It is strongly recommended that an acceptable accelerated aging procedure be developed which can be correlated with the naturally occurring chemical changes. The validity of the accelerated aging procedure will need to be established. Exposure cabinets using elevated temperatures, ultraviolet light, high oxygen concentrations, and other environmental factors can be constructed readily, and it is expected that the results of accelerated aging under such environments can be compared with results obtained in the previous work. However, it is obvious that additional work along this line will also be necessary.

In order to standardize the accelerated aging method, chemical tests will be conducted at various stages in the process in order to establish the relationship between time of aging and the degree of chemical degradation and also the reproducibility of the method. It will be desirable to conduct

all of the work with new discs which have not been recorded or so-called "white" discs.

The chemical tests should be accompanied by determinations of the sound fidelity of the records in order to determine the relationship between accelerated aging, actual aging, chemical degradation, and sound degradation.

It is realized that accelerated test results likely would not correlate exactly with actual aging and therefore should not be used as the final basis for selection of analytical methods and evaluation of aging characteristics. However, some method is needed to study the chemical reactions which accompany degradation without the necessity of continuing each series of tests for many years or decades. It is felt that suitable accelerated test procedures can be developed to shorten the time required to evaluate different analytical methods. The same accelerated procedures should also provide information on the relationships between chemical change and sound quality deterioration, as well as on the reproducibility of the analytical methods developed. Following this work, it will probably be desirable to check the results under mildly accelerated conditions as well as under actual storage conditions. The purpose in using the accelerated tests is to shorten the length of time required for evaluation of methods and techniques and for obtaining preliminary information on aging characteristics.

C. Analytical Methods

1. Infrared

The highly encouraging infrared absorption measurements discussed in the Summary of Past Results will be extended and the techniques refined. All of the details of this work are in the reports of Project 721-2. This tool will be the "work horse" for the program and the results and indications obtained heretofore will be subjected to more rigorous confirmation in order to obtain the best possible interpretation of the chemistry involved in the aging of the record.

2. Gas Chromatography

The chemical differences in the solutions of extracted material in the filtering process previously reported indicate that gas chromatography is a technique which may very well serve to confirm and amplify the data obtained in the infrared determinations. Gas chromatography is a relatively new technique which has been widely applied in the analysis of volatile hydrocarbon and other complex mixtures. Very small amounts of sample are sufficient, and compounds can be measured if they have a vapor pressure exceeding a few millimeters of mercury at elevated temperatures (up to perhaps 350°C).

Ionization type detectors are now available, which provide much greater sensitivity than the thermal types used previously.

Recent work at Southwest Research Institute has resulted in the development of techniques by which trace components of various types of samples can be removed from solution for analysis by gas chromatography. This method has been applied in the analysis of flavor and odor constituents of natural products, the analysis of automobile exhaust gases, air pollution studies, and the analysis of samples of polluted water, and others. Similar techniques will be used to treat the trace materials which are present or formed in the records as a result of chemical degradation. If these techniques are successfully developed, they will be extremely useful and may constitute the basis of a control instrument. A single determination can measure as many as fifteen or twenty constituents simultaneously even though all of them may be present in only trace amounts (parts per million or parts per billion).

In some applications, it is possible to use gas chromatography as a very efficient means of separation, followed by infrared analysis of the individual fractions.

This combination can in some cases give much more complete analytical data than either method alone.

3. Other Methods

Various other chemical and physical analytical methods will be used where applicable. Such techniques as nuclear magnetic resonance for studies of polymer structure, and electron spin resonance to study any possible free radical mechanisms, can be evaluated although their applicability is not known at the present time. Also, conventional microanalytical techniques were used in the previous work to identify chemical functional groups; these methods can be expanded and utilized. For example, stabilizer exhaustion in vinyl records may suddenly result in rapid deterioration; a surveillance procedure might be based on chemical analysis to determine unused stabilizer.

The previous work indicated that fungus attack of certain types of separators or jackets produced a by-product capable of etching some types of records. If the causative agent could be identified, control procedures might be developed which could serve as an added margin of safety if the usual methods of controlling fungus attack could not be used due to an unfavorable temperature and

humidity environment. The whole area of the relationships between biological and chemical reactions needs to be better understood, and conventional chemical analytical methods usually are sufficient for this type of work, when combined with the proper biological methods.

D. Standardization of Sound Degradation Measurements

In order to improve the correlation between sound degradation and chemical degradation, the following method will be used. All of a large batch of new discs will have a pure sine wave recorded upon them at several selected frequencies. At such times as the chemical methods detect measurable differences, the percent harmonic distortion will be determined with the frequency analyzer by the Physics Department at Southwest Research Institute.

This method should result in an excellent correlation of the infrared, gas chromatography, wet chemistry, and sound degradation. This may further result in developing methods by which degradation can be detected by chemical analysis before appreciable sound distortion has occurred.

It seems probable that further highly desirable correlation might very well be established between the methods previously proposed and nuclear magnetic resonance techniques. Such techniques are so new that it is difficult to predict their value, but they will be tried as a part of the proposed study.

E. Extension of the Program to Other Materials

It is recommended that movie film and sound recording tape also be examined in the course of this program. They are composed of various types of plastic materials, and it is logical to suppose that all of them may show somewhat the same general pattern of degradation. This can be related to sound fidelity, picture quality or any other specification of interest as developed for sound quality in the proposal. The large backlog of information regarding motion picture film may mean that little additional work will be justified unless new techniques are developed which can be applied advantageously.

IV. TIME AND COST ESTIMATES

A. Time Estimate

The proposed research program is based on a period of one year.

B. Cost Estimate

Since the proposed program is a fundamental study of phenomena which are relatively unknown, it is impossible to predict the exact amount of effort which will be required to reach a specified objective. To some extent a program can be arranged to suit whatever limitations are imposed by the availability of finances. However, it is felt that a study of this type cannot be accelerated advantageously beyond a certain

point. It is estimated that a competent program yielding valuable data can be carried on at the rate of approximately $40,000 per year. However, it is felt that a certain amount of "incubation time" will be necessary in order to make full use of the information which is being obtained; for example, an $80,000 program would probably not produce anywhere near twice as much useful information as a $40,000 program, assuming a one year study in each case.

It is strongly recommended that the Library of Congress consider a one year program at the following rate:

1. Direct Labor Costs

	Man Months	Cost
Technical Supervision	1.5	
Associate Analytical Chemist	12	
Assistant Chemical Engineer	4	
Physicist	2	
Technician	6	
Total Direct Labor		$16,800
2. Overhead - 115% of Item 1*		19,320
3. Services: Photography, Report Reproduction, etc.		150
4. Materials for use in constructing special exposure chambers		600

*Provisional rate (based on current costs) subject to adjustment to actual rate as determined by audit in accordance with ASPR, Section XV, part 2. The actual audited rate for Fiscal year ended September 30, 1958 is 122.9%.

		Cost
5.	Consumable supplies (glassware, chemicals, etc.)	$ 300
6.	Travel & Per Diem (estimated on basis of two trips to Washington for one person)	500
7.	Telephone & Telegraph (estimated to be between $50 and $75; figure of $66 used to make total come out even)	66
	Total Items 1 through 7	$37,736
	Fixed Fee (6%)	2,264
	Total Estimated Cost plus Fixed Fee	$40,000

V. BACKGROUND AND QUALIFICATIONS OF SOUTHWEST RESEARCH INSTITUTE

Southwest Research Institute is known to the Library of Congress through the previous work which has been performed. However, the work outlined in this proposal is in the Chemical Research area which constituted only a very minor part of the previous project. For this reason, some discussion of the Institute's facilities and capabilities in this particular area may be desirable.

The proposed program would be administered by the Department of Chemical Research, under the administrative direction of the Chairman, Dr. W. E. Thompson. The work would be performed primarily by staff members of the Industrial Pollution and Analytical Research Section, and the project leader would be the Manager of

that section, Dr. Herbert C. McKee. This section has had extensive experience in the analysis of trace materials by a variety of methods, and has accumulated a background of experience applicable to the proposed project. Some of the previous work which has contributed to that background is outlined below.

A. Air Pollution

Many projects have been completed to determine the nature and extent of air pollution, to study atmospheric reactions and other pollution phenomena, and to develop methods of pollution abatement. In all work relating to air pollution, a major problem is the selection of sampling and analytical methods in order to measure very low concentrations of pollutants in the parts per million and parts per billion range. In many cases, it was necessary to develop special methods and instrumentation for specific applications.

B. Water Pollution

Lake and stream surveys have been carried on, as well as studies to evaluate different methods of waste treatment. As in the air pollution work, extensive investigations have been required to develop suitable analytical methods for determining trace contaminants.

C. Food Technology

Trace components have been measured, in order to study flavor and odor characteristics of different food products. Of particular interest is the accomplishment in identifying flavor and odor constituents of coffee, using vapor phase chromatography. For this purpose, it was necessary to develop special sample preparation techniques to separate the small organic fraction from much larger amounts of carbon dioxide and water, prior to analysis by chromatography. In this way, it has been possible to distinguish between different brands of coffee, to study aging of coffee, and to study the effect of variations in the roasting operation.

The separation techniques developed for this work have wide application in other fields, and have already been used for samples of polluted water, automobile exhaust, body fluids, and other applications.

D. Instrumental Methods

A wide range of instrumental methods of analysis has been investigated. Special equipment has been constructed, in cooperation with the Department of Physics, for leak detection, industrial monitoring systems, safety equipment, and other

applications. Also, commercially available instruments have been evaluated for use in stream monitoring and various industrial uses.

The following items of analytical equipment are available:

(1) Beckman DU Spectrophotometer, with flame attachment.

(2) Perkin-Elmer Model 21 Recording Infrared Spectrophotometer.

(3) Perkin-Elmer Model 4000 Recording Ultraviolet and Near-Infrared Spectrophotometer.

(4) Sargent Model III Polarograph.

(5) Fisher-Todd Spectranal.

(6) Perkin-Elmer Model 154 Vapor Fractometer.

(7) Burrell Kromo-Tog, Model K-2, with dual columns.

} For vapor phase chromatography

(8) Bausch & Lomb dual grating Emission Spectrograph.

(9) General Electric XRD-5 X-Ray Diffraction and Fluorescent Spectrometer.

(10) RCA Electron Microscope, Model EMU-5.

(11) Varian Associates Broad Line Nuclear Magnetic Resonance Spectrometer.

(12) Varian High Resolution Nuclear Magnetic Resonance Spectrometer.

(13) Varian Electron Spin Resonance Spectrometer.

Some of these will not be applicable to the proposed program, but all are available if required.

SOUTHWEST RESEARCH INSTITUTE
CONTRACTUAL INFORMATION

SwRI Proposal No. 1-310
Purchase Request No. _____

Southwest Research Institute is a not-for-profit Trust Estate organized and existing under the laws of the State of Texas, with its principal place of business at 8500 Culebra Road, San Antonio, Texas. The Institute is tax exempt under Section 501(C)(3) of the Internal Revenue Code. The Institute presently employs approximately 450 full-time scientists, engineers, technicians, and service personnel.

The agency having cost cognizance on all Government contracts awarded this Contractor is the Office of the Auditor General, Southern District, Kelly Air Force Base, Texas.

Contractor's current financial statements are filed quarterly with the audit agency and the Air Force Administrative Contracting Officer, who has been assigned cognizance under the Coordinated Audit Program.

It is desired that a cost-plus-a-fixed-fee contract be provided. The Institute has established, based upon current costs, a provisional overhead rate of 115 per cent of direct labor. Audit by the audit agency established an overhead rate of 122.9 per cent for the fiscal year ended September 30, 1958.

The approved policy of the Institute with regard to reimbursement for transportation and other travel expenses is limited to the actual cost incurred. Subsistence expenses are further limited to an average of $15.00 per day per employee in travel status. Transportation by personal and/or Institute-owned automobiles is reimbursed at $.08 per mile as representing the actual cost of such transportation.

Government financing to the extent of current payments on account of allowable costs as provided in the clause entitled "Allowable Cost, Fixed Fee, and Payment" in accordance with paragraph (C)(5) of Section VII of the Armed Services Procurement Regulations will be requested.

The fixed fee, in the case of the Institute, is paid not only for the "know-how" which it is in a position to furnish, but for the growth and expansion of the organization which has been set up primarily for the public good through scientific progress and as a specific service to the Government. The Institute, a not-for-profit organization, does not have the capital structure to provide for expansion outside of the fee received for work performed, and nominal contributions from interested individuals and organizations. Experience has proven that funds must be available to expand facilities, also procure new and replace obsolete equipment, in order for the Institute to keep abreast with the latest in scientific development.

This proposal shall remain in effect not longer than 120 days from date of presentation. This proposal constitutes an offer and if accepted by a Notice of Award

placed in the mail addressed to Southwest Research Institute, will form a binding contract on the terms covered by this proposal. It is agreed that any such Notice of Award will be replaced at a later date by a definitive contract bearing the same date as the Notice of Award and containing the details of the agreement between the parties.

Personnel to be contacted for any negotiations required on this procurement:

Contractual: Mr. A. C. Hulen, Treasurer, GE 2-5221, Ext. 233, or
Mr. M. J. Watson, Assistant Treasurer, GE 2-5221, Ext. 227

Technical: **Dr. W. E. Thompson, Chairman, Department of Chemical Research, GE 2-5221, Ext. 234 or**
Dr. H. C. McKee, Manager, Industrial Pollution and Analytical Research, GE 2-5221, Ext. 406

Contingent Fee Statement

The bidder (contractor) represents: (a) that he has not employed or retained any company or person (other than a full-time bona fide employee working solely for the bidder (contractor)) to solicit or secure this contract, and (b) that he has not paid or agreed to pay to any company or person, other than a full-time bona fide employee working solely for the bidder (contractor) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating thereto as requested by the Contracting Officer.
(Note: For interpretation of the representation including the term "bona fide employee" see General Services Administration Regulation, Title 44, Secs. 150.7 and 150.5(d) Fed. Reg. Dec. 31, 1952, Vol. 17, No. 253).

SOUTHWEST RESEARCH INSTITUTE

By A. C. Hulen

Treasurer

APPENDIX

Professional Record Sheets are attached for personnel who will carry out the proposed program, plus others who will be available for consultation.

WILLIAM E. THOMPSON

Chairman
Department of Chemical Research

B.S. in Chemistry Metallurgy and Ceramics
University of Alabama, 1942
M.S. in Chemistry, The Johns Hopkins University, 1949
Ph.D. in Physical Chemistry, The Johns Hopkins University, 1951

Special Fields: Physical Chemistry, Petrochemicals, Polyolefins, Drilling Fluids, Chemical Treatment of Oil Wells, Oxidation of Hydrocarbons.

Experience:

Chairman, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Associate Chairman, Department of Chemistry and Chemical Engineering, Southwest Research Institute, July 15, 1957 to July 1958.

Section Chief, Basic Research Division, Sun Oil Company, 1955 to 1957. Research and development program on new polyolefins. Research in photochemical reactions, electron irradiations, catalyst systems.

Group Leader, on loan to Production Department, Sun Oil Company, 1953 to 1955. Directed research on high temperature gelation of drilling fluids, development of new drilling fluids, chemical treatment of oil wells.

Project Leader, Product Development Division, Sun Oil Company, 1952 to 1953. Development and production of oxidized waxes, research in ovidation and ozonization of petroleum sulfonates to yield new wetting agents.

Chemist, Process Development Division, Sun Oil Company, 1951 to 1952. Developed processes for oxidation of aromatics and production of cymenes. Other work on production of naphthenic acids, petroleum sulfonates and isopropanol.

Leader, Naval Research Project, The Johns Hopkins University, 1950 to 1951. Corrosion studies.

Part-time Instructor, The Johns Hopkins University, 1947 to 1950. Laboratory courses in chemistry.

Instructor, Southwestern College at Memphis, 1946 to 1947. Freshman chemistry.

WILLIAM E. THOMPSON (Cont'd)

Publications:

"Standard Electrode Potential of the Iron-Ferrous Ion Couple at 25°", Patrick, W. A., and Thompson, W. E., American Chemical Society Journal, Vol. 75, No. 5, pp. 1184 through 1187, March, 1953.

Confidential Industrial Reports.

Patents:

U.S. 2,789,123 - Treatment of Partially Oxidized Hydrocarbons; U.S. 2,767,204 - Preventing Discoloration of Partially Oxidized Petroleum; U.S. 2,767,205 - Hardening Oxidized Microcrystalline Wax
U.S. 2,828,258 - Aqueous Drilling Fluid
U.S. 2,830,018 - Secondary Recovery of Oil. About 25 patents pending in the following fields; Petrochemicals, Drilling Fluids, Polyolefins, Photochemistry, Oils, Fertilizers, Oil Well Treatments, Fracturing, Surface Active Agents, Clays, Electron Irradiations, Catalyst Systems.

Member:

American Chemical Society
Sigma Xi
Gamma Sigma Epsilon
Chi Beta Phi
American Oil Chemists Society

Rev. October/58

HERBERT C. McKEE

Manager, Industrial Pollution and Analytical Research
Department of Chemical Research

B. S., Chem., Math., Muskingum College, 1942
M. S., Ph. D., Chem. Eng., Ohio State University, 1947, 1949

Special Fields: Air Pollution, Analytical Methods, Instrumentation, Inorganic Chemical Manufacture and Technology, Catalysis, Organic Chemical Manufacture, Pilot Plant Construction and Operation, Distillation, Corrosion, Safety.

Experience:

Manager, Industrial Pollution and Analytical Research, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Manager, Air Pollution Research, Department of Chemistry and Chemical Engineering, Southwest Research Institute, February 1957 to October 1958.

Chemical Engineer, Department of Chemistry and Chemical Engineering, Southwest Research Institute, 1953 to 1957. Air Pollution and related studies, including: (1) a comprehensive survey of air pollution in a large urban and industrial area, (2) evaluation of special equipment for protection against air-borne toxic gases and aerosols, (3) development of special sampling and analytical methods, (4) the study of potential sources of vegetation damage in the vicinity of a chemical plant processing organic chemicals, (5) design of a system to dispose of radioactive waste oil, (6) a study of the causes of corrosion of a building due to air-borne corrosive agents, and others. Design, construction and operation of bench-scale pilot plant equipment. Synthetic lubricant development and evaluation. Distillation studies of sodium-mercury alloys.

Chemical Engineer, Austin Laboratories, Jefferson Chemical Company, Austin, Texas, 1950 to 1953. Product and process development in organic chemical manufacture, including pilot plant supervision.

Research Associate, Ohio State University Research Foundation, 1948 to 1950. Product and process development in inorganic chemical manufacture, including automatic control; operation of small-scale pilot units, and economic evaluation, potash fertilizer materials, products from natural potash deposits, fundamental studies on hygroscopicity of phosphate fertilizer materials.

HERBERT C. McKEE (Cont'd)

Officer, Armament Laboratory, U. S. Army Air Corps, Wright-Patterson Air Force Base, Ohio, 1944 to 1946. Research and development in rocket propulsion and control, optical bombsights and bombing equipment; testing and evaluating captured German bombsights; establishing maintenance procedure for bombing computers.

Publications:

"Estimation of Thiophene in Gasoline." Anal. Chem. 20, 301-3 (1948) (with L. K. Herndon and J. R. Withrow).

"New Developments in Air Sampling." Third Industrial Hygiene Conference Austin, Texas, May 19, 1956.

"A Study of Particulates in Automobile Exhaust." Proceedings, Semi-Annual Technical Meeting, Air Pollution Control Association, San Francisco, Calif., Nov., 1957. (With L. R. Roberts and W. A. McMahon).

"Vegetation as a Measure or Indicator of Air Pollution." Part I. The Pine (Pinus-Talda). Bulletin of the Torrey Botanical Club 85, No. 3, 197-200. May, 1958 (with F. W. Bieberdorf, C. L. Shrewsbury, and L. H. Krough).

"Improved Titrilog Sensitivity. Part II. Field Performance and Evaluation." (With W. R. Rollwitz.) (In press, Journal of the Air Pollution Control Association).

"The Houston Air Pollution Survey." Proceedings, 51st Annual Meeting, Air Pollution Control Association, May. 1958. (also, will appear in Journal of the Air Pollution Control Association.)

Member:

American Chemical Society
American Institute of Chemical Engineers
Air Pollution Control Association
Scientific Research Society of America
Registered Professional Engineer (Texas and Ohio).

Rev. December/58

FRED L. KIRCHER, JR.

Assistant Chemist
Department of Chemical Research

B.S., Chemistry, Michigan State Univ., 1946

Special Fields: Research and Development, Instrumental Chemical Analytical Methods; Oil and Gasoline Filter Engineering (auto); Petrochemical Research; Paper (natural and synthetic) research; Plastics Research (thermosetting and thermoplastic); Ordnance Engineer (propellants and liquid fuels); Physical Chemist; Microscopist.

Related Special Abilities: Mass Spectrometer (operation and repair); Spectrophotometry (operation and repair); Flame Photometry; Fluorimetry; All types of Gas Analyses; Electronic and Photometric Application and Design, Mass Spectroscopy.

Experience:

Assistant Chemist, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Assistant Chemist, Department of Chemistry and Chemical Engineering, Southwest Research Institute, February 1957 to October 1958. Applied specialized experiences with advanced electronic instrumentation to the development of specialized analytical techniques for use in research and development programs on organic, inorganic, and physical chemistry problems.

Instrumental Analytical Chemist, Chemistry Department, Champlin Oil and Refining Company, March 1955 to February 1957. Developed analytical procedures for inorganics in fuels and lubricants. Initiated use of Mass Spectrometry, Infrared and Ultraviolet Spectrophotometry, and Chromotography. Carried out some petrochemical development. Ran all A.S.T.M. gas-oil analyses. Conducted water analysis and purification studies.

Oil Filter Engineer and Paper Chemist, Filter Department, A.C. Spark Plug Division of General Motors, July 1953 to March 1955. Refined manufacture of paper oil filters, developed new types of filter media in large paper mill, improved method of resin impregnation and inaugurated rigid plant control of resin product curing. Development of gasoline and oil filters. Carried out petrochemical Research, Plastics Research, and Ion Exchange Resin Research.

FRED L. KIRCHER, JR. (Cont'd)

Chemist and Engineer, U.S. Government (Naval Research Lab., Army Ordnance, and AEC) January 1951 to July 1953. Research on Naval paints and decontamination of toxic gases. Development of propellants and liquid fuels. 81 mm Mortar research. Initiated rare earths analytical labs; designed and built photometric equipment involved; devised new methods of analysis. Chemical Engineering in separation of rare earths from phosphate rock. Laboratory Rooms and Apparatus Design. Radiation and scintillation analysis.

Analytical Chemist and Sales Engineer, Central Drug and Chemical Supply, December 1947 to January 1950. Organized wholesale drug and heavy chemical sales company. Analyzed soils, corrosion products, etc; prescribed proper chemicals. Manufactured drugs and biologicals under rigid laboratory control.

Oil Chemist, Chemistry Department, General Motors Research Corporation, February 1947 to December 1947. Oil and fuel analysis, dynamometer studies, and photographic reproductions.

Publications:

"Decontamination of Mustard Gas from Naval Paint Surfaces" - Secret.

"Analysis of Uranium by Fluorophotometric Method" - Classified.

Several Government reports of classified nature.

Patents: Method of increasing tensile, stretch, and impregnation of filter paper by use of NaCMC. Self cleaning gasoline tank gasoline filter. Other filter patents pending.

Member:

American Chemical Society
National Geographic Society
Instrument Society of America

Rev. October/58

JOHN W. RHOADES

Senior Analytical Chemist
Department of Chemical Research

B.S., Chemistry, Union College, 1942
Special Curriculum, Meteorology, Massachusetts Institute of Technology, 1942 to 1943

Special Fields: Physical Chemistry and Equipment Development; Meteorology.

Experience:

Senior Analytical Chemist, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Senior Analytical Chemist, Department of Chemistry and Chemical Engineering, Southwest Research Institute, 1948 to October 1958. Role of atmospheric pollution in paint discoloration; evaluation methods for anti-seize compounds; collapsible containers for intravenous solutions; fuel and oil analysis; cause of discoloration in processed grains; protective coating for silvered mirrors; infrared spectrophotometric analysis (automobile gases, petroleum cuts, etc.); physical evaluation of high temperature lubricants. Development of sampling method for analysis of coffee aroma by use of gas chromatography.

Chemist, Ansco Division, General Aniline and Film Corporation, Binghamton, New York, 1946 to 1947. Development of equipment for processing and handling color film.

Weather Officer, U. S. Army Air Corps, 1942 to 1946. Tactical weather forecasting and observation.

Chemist, Lake Ontario Ordnance Works, 1942. Nitric acid manufacture by ammonia oxidation.

Control Laboratory, General Electric Company, 1941. Glyptol paints and varnishes.

Patents: (Applied for)

Collapsible tube containers for intravenous solutions.

Rev. October/58

WILLIAM A. McMAHON, JR.

Chemist
Department of Chemical Research

B.S. in Chemistry, The University of Texas, 1951
M.S., Org. Chem., The University of Texas, 1954

Special Fields: Organic Chemistry; Analytical Organic Chemistry (Instrumental and Wet Methods); Infrared, visible, and ultraviolet spectroscopy.

Related Special Abilities: Analytical Organic Chemistry (Instrumental and Wet Methods).

Experience:

Chemist, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Chemist, Department of Chemistry and Chemical Engineering, Southwest Research Institute, November, 1956 to October 1958. Development of special analytical techniques for air pollution research. Analysis of particulate matter in automobile exhaust.

Analytical Chemist, Technical Department, The Chemstrand Corporation, (Nylon Division) August, 1953 to October 1956. Development of new and improved methods of analysis, trouble shooting, and special nonroutine analysis.

Teaching Fellow, The Department of Chemistry, The University of Texas, February, 1952 to May, 1953. Taught laboratory sections in elementary organic chemistry.

Member:

American Chemical Society
Alpha Chi Sigma, Professional Fraternity for Chemists and Chemical Eng.
Phi Lambda Upsilon, Honorary Society for Chemists and Chemical Eng.

WILLIAM A. McMAHON, JR. (Cont'd)

Publications:

McKee, Herbert C.; McMahon, William A.; Roberts, Louis R., "A Study of Particulates in Automobile Exhaust", Proceedings Semi-Annual Technical Meeting, Air Pollution Control Association, Nov. 18-19, 1957.

Rev. October/58

LOUIS H. KROUGH, JR.

Assistant Chemist
Department of Chemical Research

Special Fields: Analytical Chemistry and Biochemistry.

Related Special Abilities: Spectrophotometry, Chromatography, Gas Analysis.

Experience:

Assistant Chemist, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Assistant Chemist, Department of Chemistry and Chemical Engineering, Southwest Research Institute, June 1956 to October 1958. Chemical analysis of gaseous and particulate air pollutants. Operate mobile laboratory unit used in air pollution research.

Biochemist, Department of Physiology and Biophysics, School of Aviation Medicine, USAF, Randolph AFB, Texas, August 1955 to May 1956. Chemical analysis of tissue carbon monoxide, steroid compounds B and F, and serum magnesium.

Assistant Chemist, Department of Biochemistry and Physiology, Southwest Foundation for Research and Education, San Antonio, Texas, June 1954 to August 1955. Managed animal room, operated lyophilizer, prepared standard solutions; extracted and purified cholesterol from tissue perfusates and crude extracts.

Student, Chemistry Department, Trinity University, San Antonio, Texas, September 1949 to May 1955. Graduate courses in: Biochemistry, Enzymes, Radioactivity, Bacteriology, etc. Problem on chromatographic separation of algal pigments. Thesis on atmospheric particulates in progress.

Captain, Intelligence Officer, United States Air Force, February 1951 to September 1953. Instructor Officer Candidate School; Staff Intelligence Officer, Japan Air Defense Force.

Instructor, Chemistry Department, Trinity University, San Antonio, Texas, January 1947 to August 1949. Instructed lecture and laboratory of General Inorganic Chemistry, and laboratory of Organic Chemistry. Managed stockroom.

LOUIS H. KROUGH, JR. (Cont'd)

Intelligence Officer, United States Air Force, Mediterranean Theatre, September 1941 to October 1946.

Assistant Chemist, Southwestern Laboratories, Inc., San Antonio, Texas, September 1940 to September 1941. Sampled, tested, and reported on agricultural and constructional materials.

Publications:

A comparative Study of the Polyphorin Constituents of Chlorophyll Mutants of Green Algae, Texas Reports on Biology and Medicine, vol. 13, no. 2, pp. 343-344 (Summer, 1955).

Member:

American Chemical Society, Scientific Research Society of America
Society of American Bacteriologists (Texas Branch).

Rev. October/58

WILLIAM L. ROLLWITZ

Ass't. Manager, Electromechanical Section
Physics Department

B.S., Massachusetts Institute of Technology, 1951
M.S., Massachusetts Institute of Technology, 1952

Special Design Fields: Nuclear Magnetic Resonance Equipment; Paramagnetic Resonance Spectrometers; Low-Noise RF and IF Amplifiers; Low-Noise Audio Amplifiers; Narrow-Band Amplifiers; Phase Detection Circuits; Phase Shifting Circuits; Pulse Circuits; Nuclear Radiation Instrumentation; Low-Power and High-Power Transistor Circuits.

Special Theoretical Fields: Nuclear Magnetic Resonance; Microwave Spectroscopy; Circuit Synthesis and Analysis; Communication Multiplexing; Communication Theory; Electronics, Transistor Circuits.

Experience: Ass't. Manager, Electromechanical Section, July, 1957, to date.

Chief, Electron Physics Laboratory, Physics Department, Southwest Research Institute, August, 1956, to July, 1957. Study of accurate methods of velocity measurement, design of transistorized amplifying circuits for strain gage pressure transducers, and in charge of the development of instrumentation for the accelerated testing of engines, fuels, and lubricants.

Senior Research Physicist, Physics Department, Southwest Research Institute, August, 1954, to August, 1956. Design and supervision of the construction of a nuclear magnetic resonance moisture meter. Design of equipment used with microwave paramagnetic resonance measurements. Design of low-noise narrow-band low-frequency amplifiers. Design of telemetering equipment. Design of transistor circuits including amplifiers, oscillators, and pulse generators. Design of a 25-watt transistor amplifier. Design of electronic circuits for a gas pumping system analog. Design of a transistorized crevasse detector. Development of instrumentation for the accelerated testing of engines, fuels, and lubricants. Development of instrumentation for tests involving radioactive tracer techniques.

Research Physicist, Physics Department, Southwest Research Institute, 1951 to 1954. Design of nuclear magnetic resonance and paramagnetic resonance equipment. Design and construction of corona discharge particle charging system. Design of counters and switching systems. Design and construction of VHF tuning units and IF amplifiers.

WILLIAM L. ROLLWITZ

(continued)

M.S. thesis work included design and construction of four-channel multiplexed communication system with -60 db crosstalk using a special type of pulse and a continuous FM/AM Multiplier, 1951.

Research Section, Philco Corporation, Philadelphia, Pennsylvania, 1950. Design and construction of 22 MC and 45 MC-IF amplifiers for television. Design and construction of special, high gain, 4.45 MC bandwidth color television IF amplifier.

Industrial Engineering Section, Philco Corporation, Philadelphia, Pennsylvania, 1948 to 1949. Design and construction of microwave waveguide filters for microwave TV relay. Design and improvement of single subcarrier microwave TV relay.

Publications and Papers:

"Determination of Moisture by Nuclear Magnetic Resonance," J. P. O'Meara and W. L. Rollwitz, Proc. Inst. Soc. of America, Vol. 9, Paper Nr. 54-19-1, 1954.

"Applications of Nuclear Magnetic Resonance for Moisture Determination," J. P. O'Meara. T. M. Shaw, and W. L. Rollwitz, American Association of Cereal Chemists Meeting, St. Louis, Missouri, May, 1955.

"Determination of Moisture by Nuclear Magnetic Resonance, I. Theory and Design Considerations for a Practical Instrument," J. P. O'Meara and W. L. Rollwitz, American Chemical Society Meeting, Chicago, Illinois, September, 6-11, 1953.

"Determination of Moisture by Nuclear Magnetic Resonance, II. Experimental Results on Products of the Corn Wet-Milling Industry," J. P O'Meara and W. L. Rollwitz, American Chemical Society, Chicago, Illinois, September 6-11, 1953.

"Phase Sensitive Detectors for Nuclear Magnetic Resonance Signals," American Physical Society Meeting, March, 1954, Austin, Texas.

"A Nuclear Magnetic Resonance Moisture Meter," Proceedings of the National Electronics Conference, October, 1956, Chicago, Illinois.

WILLIAM L. ROLLWITZ

(continued)

Three Papers on Nuclear Magnetic Resonance and Electron Paramagnetic Resonance as Used in Non-Destructive Testing at the Starch Round Table, Otsego, New York, September, 1957.

Patents: Patent applied for on a Gas Pumping System Analog (co-author with John V. Huges, March, 1955).

"Continuous Flow Measurements by Nuclear Magnetic Resonance", December, 1956, co-authored with R. A. Garren and T. M. Shaw (applied for).

"Second-Harmonic Moisture Meter for Continuous Flow", December, 1957, (applied for).

Awards: Co-winner with J. P. O'Meara of the SwRI Swearingen Award for 1953 for work in Low Magnetic Field Nuclear Magnetic Resonance Measurements.

Member: Eta Kappa Nu.

Rev/Jan. 1958

JAMES DERWIN KING

Project Leader
Department of Physics

Northeast Junior College of L. S. U.
B.S., Electron Physics, Louisiana State University, 1951
Graduate Work, Syracuse University Ext. Div., 1952 to 1953
Graduate Work, University of Texas Ext. Div., 1954 to 1955

Special Fields: Electronic circuitry, transistor circuits, vibrating string instruments, servomechanisms, VHF telemetering systems, low noise VHF and UHF receivers, FM systems, VHF wave propagation, directional antennas, communications systems.

Experience:

Project Leader, Electronics Laboratory, Physics Department, Southwest Research Institute, August 1, 1956 to date. Conduct research and development work in the general field of electronics and electronic systems.

Research Engineer, Physics Department, Southwest Research Institute, 1953 to 1956. Research and development work in the Electromechanical Laboratory. Developed vibrating string instruments and associated electronic circuitry for use as transducers in a wide variety of physical measurements, as frequency standards, and as filters. Studied the characteristics of a large number of FM discriminators. Developed stabilized vacuum tube and transistor oscillators. Was principal engineer in the design and construction of a complete multichannel FM-FM telemetering system. Was directly concerned with the design of VHF receivers and transmitters, antennas, magnetic recording amplifiers, frequency conversion equipment as well as the over-all telemetering system design. Developed transistorized and vacuum tube servomechanism. Studied magnetic tape noise and signal-to-noise problems in FM systems. Developed magnetic tape wow and flutter cancellation circuits. Made experimental measurements in Greenland of electromagnetic and acoustic properties of ice cap for use in building crevasse detector.

Technical Engineer, Test and Engineering Department, I.B.M. Corporation, Endicott, New York, 1951 to 1953. Developed special measuring and test equipment for use in fields of servomechanisms, analog computers, pulse and special waveforms, and C.R.T. circuits.

Transmitter Engineer, Radio Station WLSU, Baton Rouge, Louisiana, 1950 to 1951. Operated and maintained FM broadcast transmitter and related equipment.

JAMES DERWIN KING

Experience: (continued)

Radio Technician, Guyton Radio Service, Massey's Service Center, and White Radio Service, Monroe, Louisiana, 1947 to 1949. Repaired and installed home and automobile radios; designed and installed two-way radio communication equipment; designed and built FM convertors, FM and TV booster, TV antennas. Assisted in development of invention to give improved usable selectivity of radio receivers.

Electronics Technician Mate, U.S. Navy, 1944 to 1946. Completed Navy ETM school; assigned to shore station for repair and installation of Navy electronics equipment (chiefly communications gear) on shipboard and at land stations.

Radio Technician, Wallace Radio Service, Monroe, Louisiana, 1942 to 1944. Repaired home and automobile radios.

Other Experience: Private investigation of low noise VHF receivers, designed and constructed HF, VHF, and UHF transmitters, receivers and antennas, designed and built autocorrelation system for improving signal-to-noise ratio. Maintained commercial 460 Mc. two-way communications system. Studies VHF wave propagation experimentally and theoretically. First-class Commercial Radiotelephone License.

General Chairman 27th (1957) Annual A.R.R.L. West Gulf Division Convention.

Patents (Pending): Device for accurately measuring phase difference between two voltages by use of digital method.

Member:

Institute of Radio Engineers
American Radio Relay League.

Rev/ Sept. 1957

FREDERICK W. BIEBERDORF

Senior Research Biologist
Department of Chemical Research

B. S., Oklahoma A & M, 1926
M. S., Ph. D., Iowa State College, 1927, 1933

Special Fields: Mycology, Bacteriology, Allergy due to Fungi and Fungicides.

Experience:

Senior Research Biologist, Department of Chemical Research, Southwest Research Institute, October 1958 to date.

Senior Research Biologist, Department of Chemistry and Chemical Engineering, Southwest Research Institute, September 1957 to October 1958.

Research Associate in Biology, Southwest Foundation for Research and Education, 1947 to September 1957, and Member, Special Staff, Department of Chemistry and Chemical Engineering, Southwest Research Institute, 1954 to September 1957. Air pollution studies, including (1) identification and diagnosis of vegetation damage due to air pollution, (2) studies of paint deterioration due to air pollutants and biological causes, (3) studies in water pollution and fish toxicity, (4) studies in fungicides. Research on the prevalence and diagnosis of mycotic diseases of man. This work has been carried out in cooperation with pathologists in various hospitals and clinical laboratories. Preparation of improved allergenic extracts from fungi and preparation of antigens used for diagnosis of certain fungus diseases. Testing chemical agents for their inhibitation of certain pathogenic fungi of man. Identification of molds and recommendations for correction of mold conditions in industrial operations.

Professor of Biology, Trinity University, 1950 to 1954; also directing graduate research in mycology and teaching a graduate course in mycology.

Mycologist Consultant, Santa Rosa Hospital, San Antonio, 1946 to date.

Captain, Medical Corps, serving as mycologist, School of Aviation Medicine, U. S. Army Air Corps, and Director, Allergy Research Laboratory, Lackland Air Base, San Antonio, 1944 to 1947. Instructor in physics, U. S. Army Air Corps, Ellington Field, Houston, 1942 to 1944, and transferred to Medical Corps.

FREDERICK W. BIEBERDORF (Cont'd)

Professor of Biology, St. Olaf College, Northfield, Minnesota, 1928 to 1942, and Ranger Naturalist, Yellowstone National Park, during summer months.

Graduate Fellowship and Instructor, Botany, Iowa State College, 1926 to 1928.

Publications:

"The Cytology and Histology of the Root Nodules of Some Leguminosae," Journal of the American Society of Agronomy, Volume 5, Number 30, 1938, Pages 375 to 389.

"Hay-Fever-Exciting Plants in San Antonio, Texas," (Summary) with S. F. Hampton, Air Surgeon's Bulletin, August 1945, Pages 259 to 261.

"Air-Borne Fungi in Allergic Disease," with S. F. Hampton, Annals of Allergy, Volume 4, 1946, Pages 23 to 32.

"Extracts of Molds Grown on Synthetic Media," with J. W. Argabrite, Journal of Allergy, Volume 1, Number 20, 1949, Pages 50 to 55.

"The Effects of the Mesquite Thorn on the Human Eye," with Harmon Brunner, M. D., Transaction of American Academy of Ophthalmology and Otolaryngology, May-June 1950, Pages 595 to 597.

"Inhibition and Enhancement of the Growth of Fungi with Streptomycin," with John B. Loefer and R. G. Weichlein, Bulletin of the Torry Botanical Club, Volume 79, May 1952, Pages 242 to 250.

"Weedicides Can Cause Havoc if Handled Carelesly; a Study of 2, 4-D Contamination of Agricultural Chemicals," with Richard Hatfield, Southern Seedsman, February 1952, Pages 25, 65, and 69.

"Coccidioidmycosis in South Texas; Cases Observed in Santa Rosa Hospital," The American Journal of Medical Technology, Volume 18, July-August 1952, Pages 199 to 204.

"Mesquite and Related Plants in Allergy," with Boen Swinny, M. D., Annals of Allergy, Volume 10, November-December 1952, Pages 720 to 724.

FREDERICK W. BIEBERDORF (Cont'd)

"Actinomycosis of a Bovine Testis," American Veterinary Medical Research, No. 122, January 1953, Pages 49 to 50.

"A Study of the Growth Response of Some Fungi to Various Concentrations of Isonicotinic Acid Hydrazide," Antibiotic and Chemotherapy, Volume 3, May 1953, Pages 513 to 520.

"Effectiveness of Various Compounds against Coccidioides immitis," with Chinn, Herman; Mitchell, R.B., and Arnold, Anna, Antibiotic and Chemotherapy, Volume 4, September 1954, Pages 982 to 987.

"An Undescribed Mesquite Rust in Texas," with Mefferd, R.B., and Blackmon, Cyril, accepted for publication by the Bulletin of the Torry Botanical Club, Volume 82, March 1955, Pages 131 to 133.

"The Use of Lyophilized Rabbit Serum for Control in Complement Fixation Tests in Coccidioidomycosis," with Chambliss, Keith Wayne, Public Health Reports, Volume 70, August 1955, Pages 771 to 774.

"Sphacelatheca Cruenta," Part I. Growth and Morophological Behavior in Pure Culture, with Blackmon, Cyril W., and Mefferd, Jr., Roy, Texas Journal of Science, Volume 8, June 1956, Pages 218 to 226.

"Vegetation as a Measure Indicator of Air Pollution," Part I. The Pine (Pinus-Taeda), F. W. Bieberdorf, C. L. Shrewsbury, H. C. McKee, L. H. Krough, Bulletin of the Torry Botanical Club, Volume 85, May 1958, Pages 197-200.

Member:

American Association for the Advancement of Science.
American College of Allergists.
American Society of Bacteriologists, Texas Branch.
Scientific Research Society of America.
Sigma Xi.
Texas Academy of Science.

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